Ultra-compact Freeform Optics for Modular CubeSats - A Novel Ultra-compact Star Scanner

Completed Technology Project (2015 - 2017)

Project Introduction

This research uses the radically emerging field of freeform optics to create new instruments and sensors for modular CubeSat designs. As CubeSat and NanoSat opportunities continue to grow, so do the demands for ever smaller instruments to fit within these volume-constrained packages.

The proposed early-stage, freeform-optic design will investigate the potential for an ultra-compact instrument design for integrated Cubesat structures that simplify the design of traditional configurations. We envision that this could be the first of many instrument/sensor systems that would be designed to fit into a standard frame, and can be easily swapped with other components. This modularity would *significantly* reduce CubeSat development time, cost, and integration.

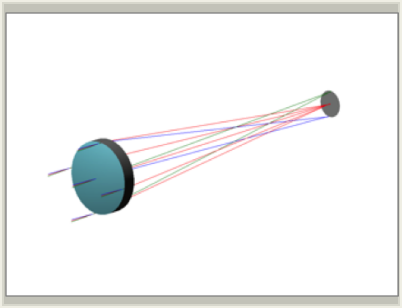
Anticipated Benefits

A spin stabilized Cubesat platform based on Goddard Spaceflight Center (GSFC) current cubesat designs can benefit from this Ultra-compact technology investment. In the current space limited design for current GSFC CubeSats, there is more than enough volume for slim sensor to enhance the Guidance Navigation and Control (GN&C) knowledge.

The combination of this radical optical design and front-end optical design research can revolutionize the way instruments/sensors in science and engineering are applied to GSFC long-term science goals.

The commerical space industry can utilize this research to manufacture new space instruments/sensors with improved surface image quality over some tradtional optics.

Other governmental agenices are seeking innovative ways to use better utilize various suborbital sounding rockets, stratospheric balloons, CubeSats and reusable suborbital launch vehicles. This research will enable these platforms to obtain an inertial reference for challenging measurements on spin-controlled platforms.



Traditional Circular Aperture Optic

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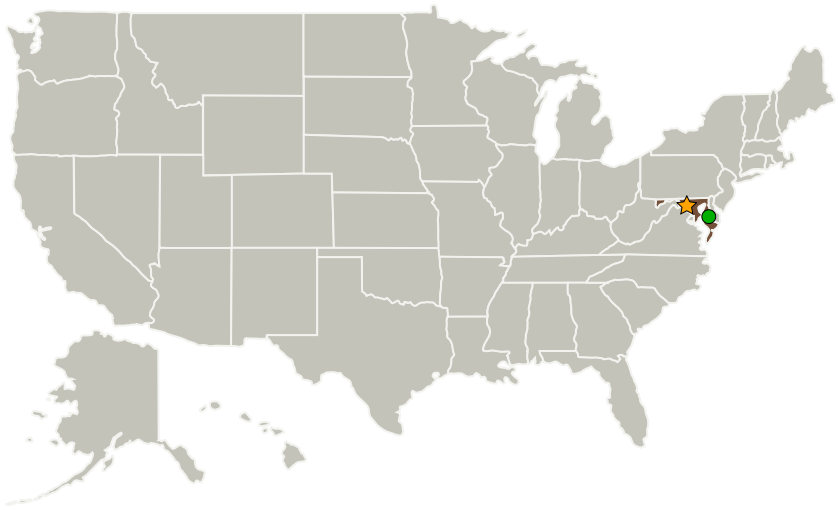
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland
●Wallops Flight Facility(WFF)	Supporting Organization	NASA Facility	Wallops Island, Virginia

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Managers:

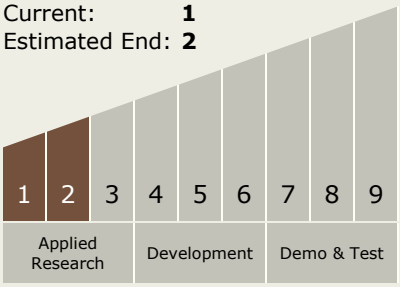
Jason W Mitchell
Daniel A Mullinix

Principal Investigator:

Sean R Semper

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **2**



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Images

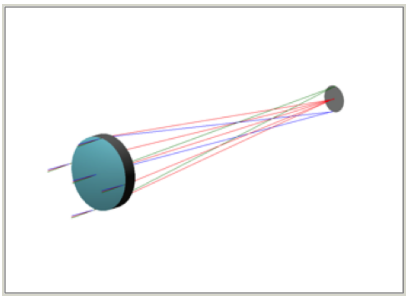

Figure 1. Traditional Circular Aperture Optic
Traditional Circular Aperture Optic
(https://techport.nasa.gov/image/18991)

Project Website:

http://aetd.gsfc.nasa.gov/

Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  - TX17.4 Attitude Estimation Technologies
    - TX17.4.3 Attitude Estimation Sensors